

CLAIMS

1. A device comprising an ultrasonic transducer element and an integrated circuit, said integrated circuit comprising a high-voltage pulser for driving said ultrasonic transducer element with high-voltage transmit pulse signals, an amplifier for receiving a receive signal from said ultrasonic transducer element, and a low-voltage transmit/receive switch having first and second switch states, said amplifier being protected from said high-voltage transmit pulse signals by said low-voltage transmit/receive switch in said first switch state and being not protected when said low-voltage transmit/receive switch is in said second switch state.

2. The device as recited in claim 1, further comprising first and second junctions, an output of said high-voltage pulser being electrically coupled to said ultrasonic transducer element through said first junction, and an input of said amplifier being electrically coupled to said ultrasonic transducer element through said first and second junctions, wherein said low-voltage transmit/receive switch comprises:

a resistor connected to provide a resistance between said first and second junctions; and

first and second transistors connected in parallel between said second junction and a bias voltage that will not damage said amplifier.

3. The device as recited in claim 2, wherein the sources of said first and second transistors are connected to a third junction, said third junction being substantially at said bias voltage, and the drains of said first and second transistors are connected to a fourth junction, said fourth junction being electrically coupled to said resistor through said second junction.

4. The device as recited in claim 3, wherein said first transistor is an NMOS transistor and said second transistor is a PMOS transistor.

5. The device as recited in claim 2, wherein the resistance of said resistor is large enough to reduce the voltage output by said high-voltage pulser to a level that will not damage said amplifier.

5 6. The device as recited in claim 2, further comprising a low-voltage pulser having an output electrically coupled to said input of said amplifier through a third junction located along the current pathway by which said input of said amplifier is electrically coupled to said second junction.

10 7. The device as recited in claim 1, wherein said high-voltage pulser comprises first and second transistors having their respective drains connected to each other at said output of said high-voltage pulser.

8. The device as recited in claim 2, further comprising a switch between said high-voltage pulser and said first junction for isolating said high-voltage pulser during receive.

15 9. A device comprising a multiplicity of ultrasonic transducer elements and a multiplicity of integrated circuits, each integrated circuit being electrically coupled to a respective ultrasonic transducer element, wherein each of said integrated circuits comprises a high-voltage pulser for driving a respective ultrasonic transducer element with high-voltage transmit pulse signals, an amplifier for receiving a receive signal from a respective ultrasonic transducer element, and a low-voltage transmit/receive switch having first and second switch states, said amplifier being protected from said high-voltage transmit pulse signals by said low-voltage transmit/receive switch in said first switch state and being not protected when said low-voltage transmit/receive switch is in said second switch state.

20 25 10. The device as recited in claim 9, wherein each integrated circuit further comprises first and second junctions, an output of said high-voltage pulser being electrically coupled to said ultrasonic transducer element through said first junction, and an input of said amplifier being electrically

coupled to said ultrasonic transducer element through said first and second junctions, wherein said low-voltage transmit/receive switch comprises:

a resistor connected to provide a resistance between said first and second junctions; and

5                   first and second transistors connected in parallel between said second junction and a bias voltage that will not damage said amplifier.

10                  11. The device as recited in claim 10, wherein the sources of said first and second transistors are connected to a third junction, said third junction being substantially at said bias voltage, and the drains of said first and second transistors are connected to a fourth junction, said fourth junction being electrically coupled to said resistor through said second junction.

15                  12. The device as recited in claim 10, further comprising a low-voltage pulser having an output electrically coupled to said input of said amplifier through a third junction located along the current pathway by which said input of said amplifier is electrically coupled to said second junction.

20                  13. A device comprising an ultrasonic transducer element and an integrated circuit, said integrated circuit comprising a high-voltage pulser for driving said ultrasonic transducer element with high-voltage transmit pulse signals during a first phase of operation, a low-voltage pulser for driving said ultrasonic transducer element with low-voltage transmit pulse signals during a second phase of operation, an amplifier for receiving a receive signal from said ultrasonic transducer element, and a low-voltage transmit/receive switch having first and second switch states, said amplifier and said low-voltage pulser being protected from said high-voltage transmit pulse signals during said first phase of operation by said low-voltage transmit/receive switch in said first switch state and being not protected when said low-voltage transmit/receive switch is in said second switch state.

14. The device as recited in claim 13, wherein said integrated circuit further comprises first and second junctions, an output of said high-voltage pulser being electrically coupled to said ultrasonic transducer element through said first junction, and an input of said amplifier being electrically coupled to said ultrasonic transducer element through said first and second junctions, wherein said low-voltage transmit/receive switch comprises:

5 a resistor connected to provide a resistance between said first and second junctions; and

10 first and second transistors connected in parallel between said second junction and a bias voltage that will not damage said amplifier.

15. The device as recited in claim 14, wherein the sources of said first and second transistors are connected to a third junction, said third junction being substantially at said bias voltage, and the drains of said first and second transistors are connected to a fourth junction, said fourth junction being electrically coupled to said resistor through said second junction.

16. The device as recited in claim 14, wherein said low-voltage pulser has an output electrically coupled to said input of said amplifier through a third junction located along the current pathway by which said input of said amplifier is electrically coupled to said second junction.

20 17. The device as recited in claim 14, further comprising a switch between said high-voltage pulser and said first junction for isolating said high-voltage pulser during receive.

25 18. A device comprising an ultrasonic transducer element and an integrated circuit, said integrated circuit comprising a high-voltage pulser for driving said ultrasonic transducer element with high-voltage transmit pulse signals during a first phase of operation, a low-voltage pulser for driving said ultrasonic transducer element with low-voltage transmit pulse signals during a second phase of operation, an amplifier for receiving a receive signal from said

ultrasonic transducer element, and a transmit/receive switch having first and second switch states, said amplifier and said low-voltage pulser being protected from said high-voltage transmit pulse signals during said first phase of operation by said transmit/receive switch in said first switch state and being not protected when said transmit/receive switch is in said second switch state.

5           19. The device as recited in claim 18, further comprising a switch between said high-voltage pulser and said ultrasonic transducer element for isolating said high-voltage pulser during receive.

10          20. The device as recited in claim 18, wherein said high- and low-voltage pulsers each comprise a respective pair of transistors having their drains connected, and said transmit/receive switch comprises a pair of transistors having their sources connected.

15          21. The device as recited in claim 20, wherein said integrated circuit further comprises first and second junctions, an output of said high-voltage pulser being electrically coupled to said ultrasonic transducer element through said first junction, and an input of said amplifier being electrically coupled to said ultrasonic transducer element through said first and second junctions, wherein the drain of one of said transistors of said transmit/receive switch is connected to said second junction and the drain of the other of said transistors of said transmit/receive switch is connected to said first junction.

20          22. A device comprising an ultrasonic transducer element, a first junction, a high-voltage pulser having an output coupled to said ultrasonic transducer element through said first junction, a second junction, a resistor located to provide a voltage drop between said first and second junctions, an amplifier having an input coupled to said ultrasonic transducer element through said first and second junctions and said resistor, and first and second transistors connected in parallel between said second junction and a bias voltage that will not damage said amplifier.

23. The device as recited in claim 22, further comprising third and fourth junctions, wherein said first and second transistors have their drains connected at said third junction and have their sources connected at said fourth junction, said fourth junction being at said bias voltage.

5               24. The device as recited in claim 22, wherein said high-voltage pulser comprises third and fourth transistors having their respective drains connected to each other at said output of said high-voltage pulser.

10              25. The device as recited in claim 24, further comprising a low-voltage pulser having an output coupled to said amplifier through said second junction, wherein said low-voltage pulser comprises fifth and sixth transistors having their respective drains connected to each other at said output of said low-voltage pulser.